Synopsis

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Impact of Water Pollution on Economic Welfare Loss of Farm Households –A Comparative Study between Upper and Lower Noyyal River Basin of Tiruppur District

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Impact of Water Pollution on Economic Welfare Loss of Farm Households – A Comparative Study between Upper and Lower Noyyal River Basin of Tiruppur District

Tiruppur District, located in the western part of Tamil Nadu, India, emerges for examining the impact of water pollution on economic welfare of farm households. The average rainfall in the District is ranged between 700mm and 1,000 mm and temperature between 25°C and 35°C (Ashwin et. al, 2022). About 60 percentage of the land in the District is allocated for agriculture, 30 percentage of the land is irrigated by Noyyal river. Textile industry is also a major source of livelihood in the District. (Salunkhe et.al, 2008)Major crops cultivated in the district include maize and sorghum, ground nut, bananas, coconut and vegetables (Brema and Arulraj, 2005).However, pollution has severely impacted the agricultural sector. The Noyyal river has recorded high levels of chemical oxygen demand (COD), up to 500 mg/L, due to industrial discharges, untreated sewage, and agricultural runoff(Pauline,2015).The above pollution issues have led to a 20-30% decrease in crop yields and a 10% reduction in farm household income. Additionally, the rising health costs associated with pollution-related factors have increased household expenditures by 15-20%. (Kaur, 2022).About 60 percentage of the population in the District dependent on agriculture and textile industry (above 2000 units) for their livelihood. The above features make Tiruppur as an ideal location to study the economic impacts of environmental pollution. Classifying the Noyyal river basin into upper and lower basins a comparative study enables a more detailed analysis of how industrial pollution impacts agriculture in different area along the river, allowing for targeted solutions to address the issue effectively (Shanmugamoorthy et al.,2023). This comparative study of the upper and lower Noyyal river basins will provide valuable insights into how pollution affects agricultural productivity and farm household welfare, informing potential policy interventions and sustainable practices.

Definition of the Problem

The studies (Singh et al., 2001, Chandrasekhar 2007, Nick Hagerty 2018, Abirami Subramanian and Sushmitha Baskar, 2022; Kirshnamoorthy et al., 2024 and Johnpaul et al., 2024) had analysed the impact of water pollution on agriculture. They assessed the impact of water pollution on agriculture on the assumption of perfect market condition in the production and consumption of farm households. According

to Pigou (1920), negative externality cause market imperfection. Market imperfection cause disequilibrium market condition. Water pollutions are the negative externalities and cause market imperfection. Moreover, the earlier studies attempted to identify the impact of water pollution on agricultural production and income by estimating separate production function and income equation for the farmers in polluted and unpolluted area. The major weakness of this approach is the implicit assumption that all farmers in both polluted and unpolluted area were aware about the causes of water pollution. This assumption is often not valid as many farmers in the polluted and unpolluted area were not aware about the causes of water pollution (Feder 1990; Guojun and Perloff 2016; and Priya 2018).

Added to this, in the study area, same farmer had landholding in both polluted and unpolluted area and cultivated crops in both. The above cases would cause sample selection problem and problem of endogeneity in the study. The sample selection problem and problem of endogeneity was not addressed in the earlier studies of Khai and Yabe (2012), Yuvasakthi and Kumar (2017). The sample selection problem was identified and addressed by Guojun and Perloff (2016) in his study on impact of water pollution on infant mortality in China due to migration. Moreover, in Tiruppur District, the impact of water pollution on agriculture in upper and lower Noyyal basin was not compared in the early studies. It was compared due to differences in the pollution sources. Present study tried to fulfil the above research gaps.

Research Questions

- What are the causes and consequences of water pollution in Tiruppur District?
- Is there any difference in the causes and consequences of water pollution between upper and lower Noyyal river basin of Tiruppur District?
- What are the determinants of water pollution in upper and lower Noyyal river basin of Tiruppur District?
- Is there any impact of water pollution on welfare and welfare loss of farm households in upper and lower Noyyal river basin in Tiruppur District?

Objectives and Scope of the Research Work

The major objective of the present study was to analyse the, to find out the welfare loss farm households in upper and lower Noyyal river basin. The following are the specific objectives of the study;

- To study the socio economic profile of farm households in upper and lower Noyyal river basin in Tiruppur District
- To identify and to compare the causes and consequences of water pollution between upper and lower Noyyal river basin
- To assess the impact of water pollution on economic welfare of farm households in upper and lower Noyyal river basin
- To analyse the impact of water pollution on economic welfare loss of farm households

Hypotheses

The following null hypotheses were tested;

- There is no significant difference in the causes and consequences of water pollution between upper and lower Noyyal river basin
- Water pollution is independent of the causes of water pollution
- Pollution factors are independent of the economic welfare of farm households in polluted area
- Pollution factors are dependent on the economic welfare of farm households in unpolluted area
- Welfare loss of farm households in polluted area is independent of pollution factors

Scope of the Study

The current study attempted to analyse the impact of water pollution on welfare loss of farm households in the upper and lower Noyyal river basin in Tiruppur district. The causes and consequences of water pollution were compared between upper and lower Noyyal river basin as the pollution sources differed. This study aims to address significant research gaps in the field of water pollution and its impact on agriculture. Earlier studies (Singh et al., 2001, Chandrasekhar 2007, Hagerty 2018, Abirami Subramanian and Sushmitha Baskar 2022, Kirshnamoorthy et al., 2024, Johnpaul et al., 2024) assumes perfect market condition and assessed the impact of water pollution on farm sector. In the present study, water pollution is a negative externality which causes imperfect market condition. Moreover, in the study area, the sample farmers had land holding in both polluted and unpolluted area which creates sample selection problem. All the farmers were not aware about the causes of water

pollution in the study area which creates problems of endogeneity. Current study on the impact of water pollution on welfare loss of farm households in upper and lower Noyyal river basin was analysed by addressing the market imperfection, sample selection problem and problem of endogeneity.

Methodology

The present study was based on primary data. The sample farmers in the Tiruppur district were chosen using multistage sampling technique. In the first stage, nine revenue villages such as Tiruppur North, Tiruppur South, Avinashi, Uthukuli, Palladam, Dharapuram, Kangayam, Udumalpet and Madathukulam (taluks) in Tiruppur district were identified. The taluks located in the Noyyal river basin were taken into consideration because industrial waste is primarily discharged into it and it is a major source of water pollution. The Noyyal river traverses the taluks of Tiruppur North, Tiruppur South, Avinashi, Uthukuli, Kangayam, and Madathukulam. Among the above taluks, the taluks such as the Tiruppur North, Tiruppur South, Uthukuli and Kangayam were selected as they were high industrial concentrated taluks in the second stage. The taluks of Avinashi and Madathukkulam were omitted as the industrial concentration was less in the above mentioned taluks. The selected taluks were classified as the upper and lower Noyyal river basin based on the location of the taluks in the Noyyal river basin. Accordingly, Tiruppur north and Tiruppur south were classified as the taluks of upper Noyyal river basin and Kangeyam and Uthukuli were the taluks of lower Noyyal river basin in Tiruppur district in the third stage. In the fourth stage, the polluted and unpolluted villages were identified based on the pollution status declared by the pollution control board as well as the water sample tested for water pollution in the selected villages. Accordingly, the pollution affected villages in upper taluks were Neruperichal, Mannarai Veerapandiand and Mangalam. The unpolluted villages were Pongupalayam, Perumanallur, Muthuanampalayam and Muthalipalayam. In the lower taluks, the identified pollution affected villages were A.Periyapalayam, S.Periyapalayam, Tammarettipalayam and Maravapalayam. The pollution not affected villages were Kunnathur, Nettichipalayam, Mangala Patti, and Nathakadiyur.

In the next stage, the size of farmers cultivated in pollution affected area and unpolluted area were decided based on the proportionate sampling. Accordingly, 52.69percentage of farmers in polluted area and 47.31 percentage of farmers in

unpolluted area in Tiruppur north taluk were decided. In Tiruppur south taluk, 56.64 percentage of farmers in polluted area and 43.36 percentage of farmers in unpolluted area, in Uthukuli taluk, 42.29 percentage of farmers in polluted area and 57.71 percentage of farmers in unpolluted area and in Kangeyam taluk, 52.94 percentage of farmers in polluted area and 47.06 percentage of farmers in unpolluted area were decided. In total, 206 farmers in the upper Noyyal river basin and 294 farmers in lower Noyyal basin were selected based on proportionate sampling technique.

Collection of Data

As the study was mainly based on primary data, interview schedule was constructed to collect the information on socioeconomic profile of farm households, cropping patterns, causes, consequences and the impact of water pollution on the agricultural sector. A pilot study was conducted from 100 farmers to identify the gap in the interview schedule. Based on the pilot study, the interview schedule was modified and validated. Final survey was conducted in the period of January 2020 –July 2021. Direct personal interview was conducted from the farmers in the selected villages of selected taluk to collect the information. The causes and consequences of water pollution in the interview schedule were validated based on Cronbach's Alpha which was greater than 0.7suggested by Nunnally and Bernstein, 1994.

Specification of Econometric Models and Estimation Issues

To address the imperfect market condition, sample selection problem and the problem of endogeneity, Heckman models were specified.

The following are the statistical and econometric tools used to fulfil the objectives of the study;

- **Five point rating scaling technique** was used to measure the causes and consequences of water pollution as they are the farmer responses.
- **Mann -Whiteney U statistics** was applied to compare the causes and consequences of water pollution between upper and lower Noyyal river basin.
- **Probit regression analysis** was specified to identify the factors determining the water pollution.

- **Heckman based endogenous switching hedonic model** was specified to assess the impact of water pollution on land value.
- **Heckman based endogenous switching regression mode**l was specified to assess the impact of water pollution on area under cultivation, technical efficiency, net farm income and consumption expenditure of households.
- **Heckman type Tobit model** was specified to assess the impact of water pollution on land value loss, area under cultivation loss, production loss, technical efficiency loss, net farm income loss and consumption expenditure loss.
- **Endogenous switching frontier production function** was used to assess the impact of water pollution on farm production and technical efficiency.

Major Findings of the Study

Socio, Economic and Demographic Profile of the Selected Farmers

- In all the selected taluks, more than 90 percentage of the farmers were married. The female headed household was higher in upper Noyyal river basin compared to lower Noyyal river basin. Nuclear family system was predominant in the unpolluted area while joint family system was predominant in the polluted area. None of the farmers were illiterates in both polluted and unpolluted area. Higher size of land holding was noted in the polluted area while higher family income, household expenses and savings of farmers were noticed in the unpolluted area. Higher percentage of the farmers were in the age group of 36-45 years and small family size with 1-5 members was predominant in both polluted and unpolluted area.

Causes of Water Pollution

- The farmers in the polluted area, considered the following as the primary causes of water pollution viz. 'disposable of textile industrial waste in the nearby water bodies', 'disposal of textile industrial waste in the underground,' 'mixing of domestic waste in the water bodies', 'Pumping the industrial waste in the farm land' and 'mixing of partial treated waste water in the water bodies'

Comparison of Causes of Water Pollution between upper and lower Noyyal river basin -Mann Whiteney test

- It revealed that the causes of water pollution differed significantly between upper and lower Noyyal river basin. The causes of water pollution in the polluted area of upper and lower Noyyal river basin were not same.

Determinants of Water Pollution for upper Noyyal river basin – Probit Regression Analysis

- The pollution factors petering to, 'disposal of textile industrial wastes in the nearby water bodies', and 'mixing of partial treated waste water in the water bodies' were statistically significant to determine the water pollution in upper Noyyal river basin. Increase in disposal of textile industrial wastes in the nearby water bodies and mixing of partial treated waste water in the water bodies had increased the water pollution.

Determinants of Water Pollution for lower Noyyal river basin– Probit Regression Analysis

- In the lower Noyyal river basin, pollution factors such as, 'disposal of textile industrial waste in the water bodies', 'disposal of textile industrial waste in the underground', 'pumping the industrial wastes in the farm land' and 'mixing of partial treated waste water mixed in the water bodies' were statistically significant.

Consequences of Water Pollution – Farmer Responses

- The water colour changed and contamination of chemicals in the water were the major consequences of water pollution in the upper Noyyal river basin. In the lower Noyyal river basin, ground water is affected, water level declined and changing of cropping pattern were the major consequences of water pollution responded by the farmers in the study area.

Comparison of Consequences of Water Pollution between upper and lower Noyyal river basin -Mann Whiteney Test

- The results of Mann Whiteney test showed that the consequences of water pollution differed significantly between upper and lower Noyyal river basin.

Asset Holding

- Higher value of land assets was owned by the farmers in lower Noyyal river basin compared to upper Noyyal river basin.

Impact of Water Pollution on Land Asset – Hedonic Model

- The pollution factor 'disposal of textile industrial waste in the nearby water bodies', was a significant factor in determining the land value in the polluted area of upper Noyyal river basin. The 'disposal of textile industrial waste in underground,' was statistically significant in the polluted area of lower Noyyal river basin. In unpolluted area, none of the pollution factor had turned out to be statistically significant to determine the land value.

Asset Loss in Polluted Area

- Comparatively higher land assets loss was noticed in the polluted area of lower Noyyal river basin than in upper Noyyal river basin.

Impact of water Pollution on Land Value Loss

- The 'disposal of textile industrial waste in the nearby water bodies', in upper Noyyal river basin and' disposal of textile industrial waste in the underground' in the lower Noyyal River basin were the significant factors determining the land value loss.

Cropping Pattern in the Study Area

- In the polluted area of upper Noyyal river basin, maize, sorghum and groundnut were the major crops cultivated. The important crops cultivated in the unpolluted area of upper Noyyal river basin were maize, sorghum and coconut. In lower Noyyal river basin, the major crops cultivated in polluted taluks were maize and sorghum. In unpolluted area of lower Noyyal river basin, major crops cultivated were groundnut followed by maize and sorghum.

Impact of Water Pollution on Area under Cultivation

- In both polluted area of upper and lower Noyyal river basin, the pollution factors exhibited significant relationship with area under cultivation. In the upper Noyyal river basin, the pollution factor, 'disposal of textile industrial waste in the nearby water bodies' was statistically significant while 'disposal of textile industrial waste in the underground' was statistically significant to determine the area under cultivation in the lower Noyyal river basin.

Area under cultivation loss in polluted area

- Higher area under cultivation loss was noticed in the polluted area of upper Noyyal river basin compared to lower Noyyal river basin.

Impact of Water Pollution on Area under Cultivation Loss

- 'Disposal of textile industrial wastes in the water bodies' was a significant factor in determining the area under cultivation loss in upper Noyyal river basin while 'disposal of textile industrial wastes in the underground' in the lower Noyyal river basin had exhibited significant relationship with area under cultivation loss. The above mentioned pollution factor had increased the area under cultivation loss in polluted area.

Farm Production

- Higher farm productivity was noticed in upper Noyyal river basin compared to lower Noyyal river basin.

Impact of Water Pollution on Farm Production - Stochastic Frontier Production Function

- The mean technical efficiency was higher in the unpolluted area than in polluted area in both upper and lower Noyyal river basin. The log likelihood ratio test was statistically significant in polluted area. It indicated the presence of technical inefficiency in the production function of farmers in polluted area of both upper and lower Noyyal river basin. The mean technical efficiency in the upper Noyyal river basin was higher than in lower Noyyal river basin.

Production Loss

- The crop production loss per hectare was higher in lower Noyyal river basin compared to upper Noyyal river basin.

Impact of Water Pollution on Production Loss

- In upper Noyyal river basin, 'disposal of textile industrial wastes in the water bodies' was statistically significant to determine the production loss. In the lower Noyyal river basin 'disposal of textile industrial wastes in the underground' was statistically significant to determine the production loss.

Impact of Water Pollution on Technical Efficiency

- In the polluted area of upper Noyyal river basin, the pollution factor 'disposal of textile industrial waste in the nearby water bodies' was statistically significant to determine the technical efficiency. In the lower Noyyal river basin, 'disposal of textile industrial waste in underground' was the significant factor determining technical efficiency.

Technical Efficiency Loss

- The mean technical efficiency loss was higher in lower Noyyal river basin than in the upper Noyyal river basin.

Impact of Water Pollution on Technical Efficiency Loss

- The pollution factors such as 'disposal of textile industrial waste in the nearby water bodies' in the upper Noyyal river basin and 'disposal of textile industrial waste in the underground' in the lower Noyyal river basin were the significant factors determining technical efficiency loss in the polluted area.

Net Farm Income

- The net farm income earned by the farmers in the upper Noyyal river basin was higher compared to lower Noyyal river basin.

Impact of Water Pollution on Net Farm Income

- The pollution factors ' disposal of textile industrial waste in the nearby water bodies' in the upper Noyyal river basin and 'disposal of textile industrial waste in the underground' in the lower Noyyal river basin were the significant factors determining net farm income. The pollution factors had negatively affected the net farm income in polluted area of both upper and lower Noyyal river basin.

Net Farm Income Loss

- The net farm income loss was higher in the lower Noyyal river basin compared to upper Noyyal river basin.

Impact of Water Pollution on Net Farm Income Loss

- The pollution factors such as the 'disposal of textile industrial waste in the nearby water bodies' and 'disposal of textile industrial waste in the underground' were the significant factors influencing net farm income loss in polluted area of upper and lower Noyyal river basin respectively.

Consumption Expenditure of the Farm Households

- The household expenditure was higher in lower Noyyal river basin than in upper Noyyal river basin. The farmers in unpolluted area incurred higher amount of both food and non food expenditure than the farmers in polluted area.

Impact of Water Pollution on Consumption Expenditure of Farm Households

- Nonfarm income was a significant factor determining the consumption expenditure in the polluted area while in unpolluted area, both farm income and non farm income were the significant factors determining the consumption expenditure of upper and lower Noyyal river basin.

Consumption Expenditure Loss of Farm Households in Polluted area

- The annual consumption expenditure loss was higher in lower Noyyal river basin compared to upper Noyyal river basin.

Impact of Water Pollution on Household Consumption Expenditure Loss

- The pollution factor 'disposal of textile industrial wastes in the water bodies' in the upper Noyyal river basin and 'disposal of textile industrial wastes in the underground' in the lower Noyyal river basin were statistically significant to increase the consumption expenditure loss.

Conclusion

- In the upper Noyyal river basin, disposal of textile industrial waste in the nearby water bodies was the major factor causing water pollution.
- In the lower Noyyal river basin, the disposable of industrial waste in the underground through the bore well was the major factor determining the water pollution.
- The pollution factor 'disposal of textile industrial waste in the nearby water bodies' was a significant factor in determining the economic welfare and welfare loss of farm households in the upper Noyyal river basin.
- The pollution factor 'disposal of textile industrial waste in the underground ', was a significant factor in determining the economic welfare and welfare loss of farm households in the lower Noyyal river basin.

- The farm production loss, income loss and consumption loss were higher in the lower Noyyal river basin compared to upper Noyyal river basin. It was due to the fact that the farmers in the upper Noyyal river basin diversified their economic activity from farm to non farm sector. In lower Noyyal River basin, the farmers were unable to diversify their economic activity from farm to non farm sector.

Suggestions

- The existing monitoring team for monitoring the disposable of industrial waste in the water bodies in Tiruppur district may be strengthened to implement and follow the strict action.
- All the industrial units particularly small scale units must be encouraged to connect with the common effluent treatment plant. It would reduce the water pollution.
- The dyeing industrial units pumped the waste water in the underground through bore well which must be monitored by the pollution control board regularly. It may reduce the problem of ground water pollution.
- The process of recycling the industrial effluents may be undertaken through government incentives along with industries which would reduce the problem of water pollution.

Paper Published

Published two paper in UGC Care Group – I and Group –II Journals

- Nirmala, R., & Gandhimathi, S. (2024). Impact of waste water treatment on area under cultivation in Tiruppur District, Tamil Nadu – Projection based on willingness to pay approach. *Current Agricultural Research, 12*(2), 578-565. https://doi.org/10.12944/CARJ.12.2.07
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